

WHAT IS CLAIMED IS:

1        1.        A piezoelectric vibrator unit in which first conductive layers to be  
2        internal individual electrodes and second conductive layers to be internal  
3        common electrodes are alternately and overlappingly stacked on each other  
4        while sandwiching piezoelectric materials therebetween, comprising:

5                a through hole piercing through the piezoelectric materials in at least  
6        one end portions thereof for being filled with a conductive material such that at  
7        least either the first conductive layers or the second conductive layers are  
8        connected with each other; and

9                an external electrode layer for connecting the conductive material in  
10       the through hole.

1        2.        The piezoelectric vibrator unit as set forth in claim 1, wherein the unit  
2        includes a plurality of piezoelectric vibrators and the through hole for  
3        connecting the first conductive layers is formed in every piezoelectric vibrator.

1        3.        The piezoelectric vibrator unit as set forth in claim 1, wherein the  
2        conductive layers on which the through holes are formed are electrically  
3        connected by the conductive material filling the though hole.

1        4.        The piezoelectric vibrator unit as set forth in claim 1, wherein the  
2        through holes of the respective layers is situated on the same line.

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1 5. The piezoelectric vibrator unit as set forth in claim 1, wherein the  
2 through holes alternate ones of the respective layers are situated on the same  
3 line.

1 6. The piezoelectric vibrator unit as set forth in claim 1, end faces of the  
2 respective conductive layers are situated nearer to a center portion than end  
3 faces of the piezoelectric vibrator.

1 7. The piezoelectric vibrator unit as set forth in claim 1, wherein the width  
2 of the though hole is larger than the thickness of the piezoelectric material of  
3 each layer.

1 8. The piezoelectric vibrator unit as set forth in claim 1, wherein the  
2 respective piezoelectric vibrators are divided into a comb-like shape by slits  
3 such that non-vibrating regions of the respective piezoelectric vibrators are  
4 connected with each other.

1 9. The piezoelectric vibrator unit as set forth in claim 1, the external  
2 electrode layer is made of a material identical with a material of the internal  
3 electrodes.

1 10. The piezoelectric vibrator unit as set forth in claim 1, wherein one face  
2 extending in a longitudinal direction of the each piezoelectric vibrator is fixed to  
3 a fixing base

1 11. The piezoelectric vibrator unit as set forth in claim 1, wherein the  
2 piezoelectric vibrator is of longitudinal vibration type which expands and  
3 contracts in a direction perpendicular to the stacking direction of the conductive  
4 layers and the piezoelectric materials.

1 12. The piezoelectric vibrator unit as set forth in claim 1, wherein a  
2 segment electrode and a common electrode is provided as the external  
3 electrode layer.

1 13. The piezoelectric vibrator unit as set forth in claim 1, wherein an  
2 external electrode connected to the external electrode layer is provided on an  
3 end portion of the piezoelectric vibrator a side of which the through hole is  
4 absent.

1 14. A method of manufacturing a piezoelectric vibrator unit, comprising  
2 the steps of:

3 (a) preparing a green sheet in which through holes are opened in the  
4 vicinity of at least one end portion thereof which is to be a vibrating region of the  
5 piezoelectric vibrator;

6 (b) forming a conductive material layer on the green sheet while filling  
7 the though holes such that a strip-like non-conductive region is formed in an  
8 area where is nearer to a center portion thereof than the though holes and is to  
9 be coincident with a distal end of an internal common electrode;

10 (c) repeating the steps (a) and (b) to stack required number of layers  
11 until through holes to be electrically connected with a segment electrode are

12 filled;  
 13 (d) baking the above to form a single piezoelectric material diaphragm;  
 14 and  
 15 (e) forming slits on the piezoelectric material diaphragm so as to  
 16 elongate to an area where at least the conductive layers can be separated from  
 17 each other to constitute piezoelectric vibrators.

1 15. A method of manufacturing a piezoelectric vibrator unit, comprising  
 2 the steps of:

3 (a) preparing a green sheet in which through holes are opened in the  
 4 vicinity of at least one end portion thereof which is to be a vibrating region of the  
 5 piezoelectric vibrator;

6 (b) forming a conductive material layer on the green sheet while filling  
 7 the through holes such that a strip-like non-conductive region is formed in an  
 8 area where is nearer to a center portion thereof than the through holes and is to  
 9 be coincident with a distal end of an internal common electrode;

10 (c) preparing a next green sheet in which through holes are opened in  
 11 the vicinity of at least one end portion thereof which is to be the vibrating region  
 12 of the piezoelectric vibrator;

13 (d) forming a conductive material layer on the green sheet while filling  
 14 the through holes such that a strip-like non-conductive region where is to be  
 15 coincident with a distal end of an internal individual electrode;

16 (e) repeating the steps (a) to (d) to stack required number of layers  
 17 until through holes to be electrically connect with a segment electrode is filled;

18 (f) baking the above to form a single piezoelectric material diaphragm;

19 and  
 20 (g) forming slits on the piezoelectric material diaphragm so as to  
 21 elongate to an area where at least the conductive layers can be separated from  
 22 each other to constitute piezoelectric vibrators.

1 16. The piezoelectric vibrator unit as set forth in claim 14, wherein the  
 2 through holes are opened so as to coincide with an arrangement pitch of the  
 3 piezoelectric vibrators.

1 17. The piezoelectric vibrator unit as set forth in claim 15, wherein the  
 2 through holes are opened so as to coincide with an arrangement pitch of the  
 3 piezoelectric vibrators.

1 18. The piezoelectric vibrator unit as set forth in claim 14, wherein the slits  
 2 are formed so as to coincide with an arrangement pitch of through holes formed  
 3 in one end portion which is to be a free end of the piezoelectric vibrator.

1 19. The piezoelectric vibrator unit as set forth in claim 15, wherein the slits  
 2 are formed so as to coincide with an arrangement pitch of through holes formed  
 3 in one end portion which is to be a free end of the piezoelectric vibrator.

1 20. An ink jet recording head comprising:  
 2 a piezoelectric vibrator unit in which first conductive layers to be  
 3 internal individual electrodes and second conductive layers to be internal  
 4 common electrodes are alternately and overlappingly stacked on each other

5 while sandwiching a piezoelectric material therebetween, including:  
6 a through hole piercing through the piezoelectric materials in  
7 at least one of end portions of thereof for being filled with conductive material  
8 such that at least one of the first conductive layers with each other and the  
9 second conductive layers with each other are connected; and  
10 an external electrode layer for connecting the conductive  
11 material in the through hole;  
12 a channel unit including a pressure generating chamber pressurized  
13 by the piezoelectric vibrator unit, which communicates with both of a reservoir  
14 and a nozzle orifice; and  
15 a head holder for holding the piezoelectric vibrator unit and the  
16 channel unit.